Introduction 1

The Intel740™ graphics accelerator is a graphics hardware accelerator providing a variety of features that enhance the speed and visual quality of 2D and 3D applications. The Intel740™ chip feature set includes DVD, video capture, VBI and intercast programming capabilities. The Intel740 chip works with the OpenGL*, Microsoft DirectX*, and Win32* programming interfaces. Both the OpenGL and the DirectX APIs give graphics applications a standard way to invoke 2D, 3D and video graphics rendering functions and allow a software application to be hardware independent.

The Intel740 graphics accelerator OpenGL driver set runs on personal computers that are based on the Intel Architecture with Accelerated Graphics Port (AGP) support and have Microsoft WindowsNT* 4.0 and Windows95* with USB support or newer operating systems with the OpenGL 1.1 application programming interface (API). For WindowsNT 4.0 (or newer), the OpenGL driver set is based on the Mini Client Driver (MCD) implementation and for Windows95 with USB support or newer operating systems, the OpenGL driver set is based on the Independent Client Driver (ICD) implementation. The Intel740 graphics accelerator DirectX driver set runs on personal computers that are based on the Intel Architecture with AGP support and have the Microsoft Windows98, Windows95 with USB support, or WindowsNT 5.0 operating system with DirectX 5.0 (or newer) and Win32 programming interfaces. This manual presents the Intel740 graphics accelerator accelerated functions that are callable from OpenGL, DirectX and Win32 application programs.

1.1 About This Manual

This manual is intended for graphics tool or application programmers who are experienced with writing 2D, 3D, or video graphics applications. The manual assumes that the programmer has a working knowledge of the vocabulary and principles of graphics applications. It is intended for programmers who plan to use the DirectX, OpenGL and Win32 software API interfaces.

Chapter 1, “Introduction” — introduces the Intel740 chip features and API support.

Chapter 2, “Hardware Capabilities” — provides a hardware system overview and reviews the hardware functionality of the Intel740 chip. This chapter describes in detail the 3D rendering, 2D display and video capabilities.

Chapter 3, “Programming Environment” — describes the OpenGL and DirectX APIs for the Windows95, Windows98, and WindowsNT operating environments.

Chapter 4, “Performance Considerations” — discusses programming approaches to maximize performance. Throughput, duty cycle, and memory bandwidth sensitivities on performance are addressed. Programming tips and strategies for using the Intel740 chip are provided. OpenGL performance guidelines are also discussed.

Appendix A, “Creating a VPE Port Sample” — is a complete listing of sample code which shows the user how to create a VPE port.

1.2 Intel740™ Graphics Accelerator Features

This section offers a brief overview of the most prominent Intel740 chip features. The Intel740 graphics controller may contain design defects or errors known as errata. Current characterized errata are available on request.

Table 1-1. Intel740™ Graphics Accelerator Feature Summary

HYPER PIPELINED ARCHITECTURE	2D & DISPLAY FEATURES
• Direct Memory Execution (DME)	• Display Resolution: 640x480x8 up to 1280x1024x16 @ 56Hz– 85Hz Refresh Rate
• 0.85 Mega-Triangles/Second Peak†	• Hardware Cursor
• 425-500K Triangles/Second Full Featured Sustained 3D Performance†	• Hardware Overlay
• 45-55 Mega-Pixels/Second Full Features (>140 Pixel Triangles) Sustained 3D Performance†	• Blitter Engine
• Full Sideband Accelerated Graphics Port	• Color Expansion
• Parallel Execution	
• Optimized for the Intel® 440LX AGPset	
3D FEATURES	**VIDEO IN/OUT FEATURES**
• Z-Buffering	• Programmable Video Output Characteristics (VGA, SVGA, NTSC, PAL)
• Back Face Culling	• Video Capture Support (16- or 8- bit Uni-Directional Capture Port)
• Antialiasing	• Scaling of the Full Motion Video Data
• Flat and Gouraud Shading	• Full Motion Video Overlaid with Frame Buffer
• Specular Highlighting	• Intercast & VBI Support
• Fog with RGB Components	• MPEGII DVD Capability
• Color Alpha Blending	
• Color Dithering	
• Stippling or “Screen Door” transparency	
• Texture Color Keying	
• Per Pixel Perspective Correct Texture Mapping	
• Mipmapping with Trilinear Filtering 1024x1024 to 1x1	
• Texture Formats: 1, 2, 4 or 8-bit palettized; ARGB 1555 0565 4444; Compressed AYUV 0422 0555 1544.	
• Texture Memory Limited Only by System RAM	
• Optimized for 800x600x16 and 640x480x16 Display Resolution	

† See “Performance Strategies And Measurements” on page 4-1 for the system configuration used to generate these performance statistics.

1.3 Related Documents

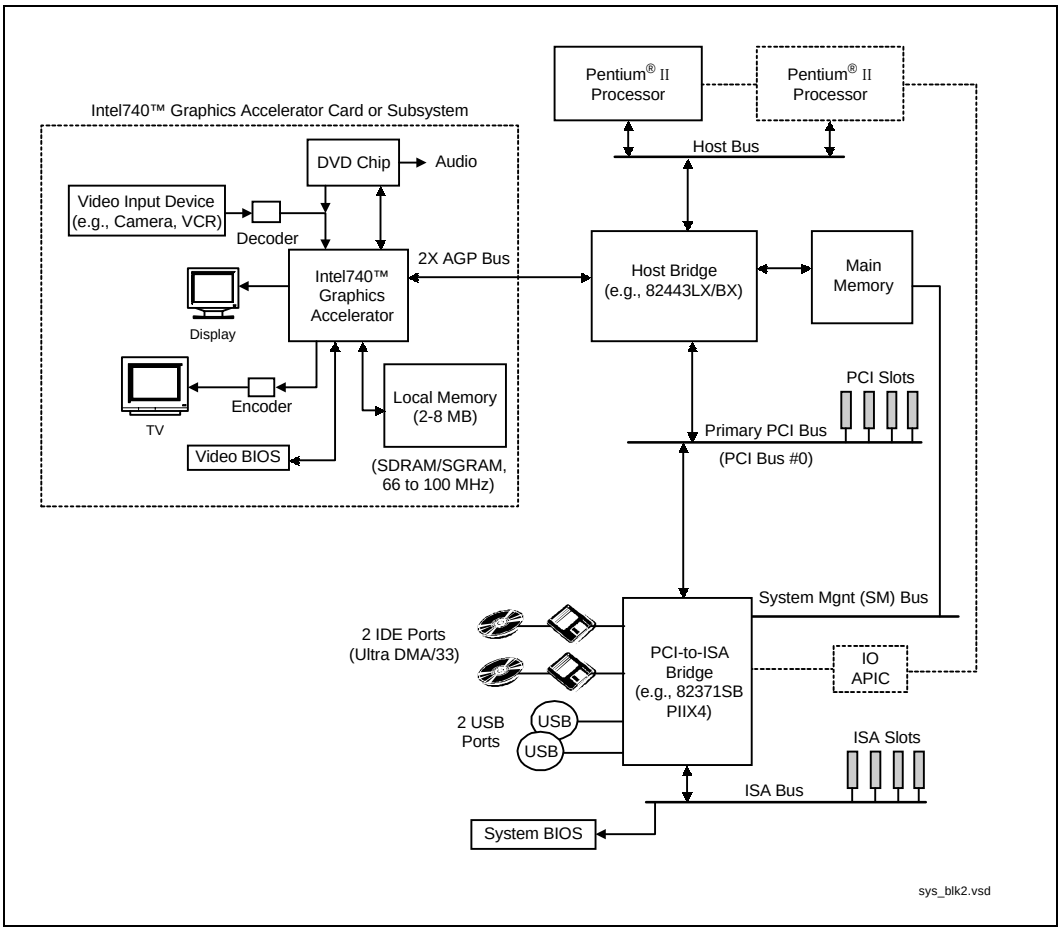
Refer to the following materials for information outside the scope of this document.

- Intel740™ Graphics Accelerator Hardware Specification Update
- Intel740™ Graphics Accelerator Software Specification Update
- Intel740™ Graphics Accelerator Datasheet (order number 290618)
- Silicon Graphics OpenGL* SDK
- *OpenGL Programming Guidelines*, Second Edition; Woo, Mason; Neider, Jackie; Davis, Tom; Addison-Wesley Developer Press; 1997.
- The OpenGL Graphics System: A Specification (Version 1.1), by Silicon Graphics Inc., 1995
- OpenGL Reference Manual, Second Edition, by OpenGL ARB, Addison-Wesley, 1997
- OpenGL Programming Guide, Second Edition, by OpenGL ARB, Addison-Wesley, 1997
- Computer Graphics Principles and Practice, by Foley, van Dam, Feiner and Hughes, 2nd edition in C, Addision-Wesley, 1997
- Microsoft DirectX* Media 5.0 SDK
- Win32 SDK

Hardware Capabilities 2

Optimized for the new Accelerated Graphics Port (AGP), the Intel740™ chip delivers high performance in 2D and 3D graphics rasterization. In addition, the Intel740 chip has a video capture port that allows easy hookup to video conferencing systems such as POTS (Plain Old Telephone Set) video conferencing applications and Intercast technology. Each hardware feature is discussed in the following sections:

Figure 2-1. System Block Diagram with Intel740™ Graphics Accelerator



2.1 Architectural Overview

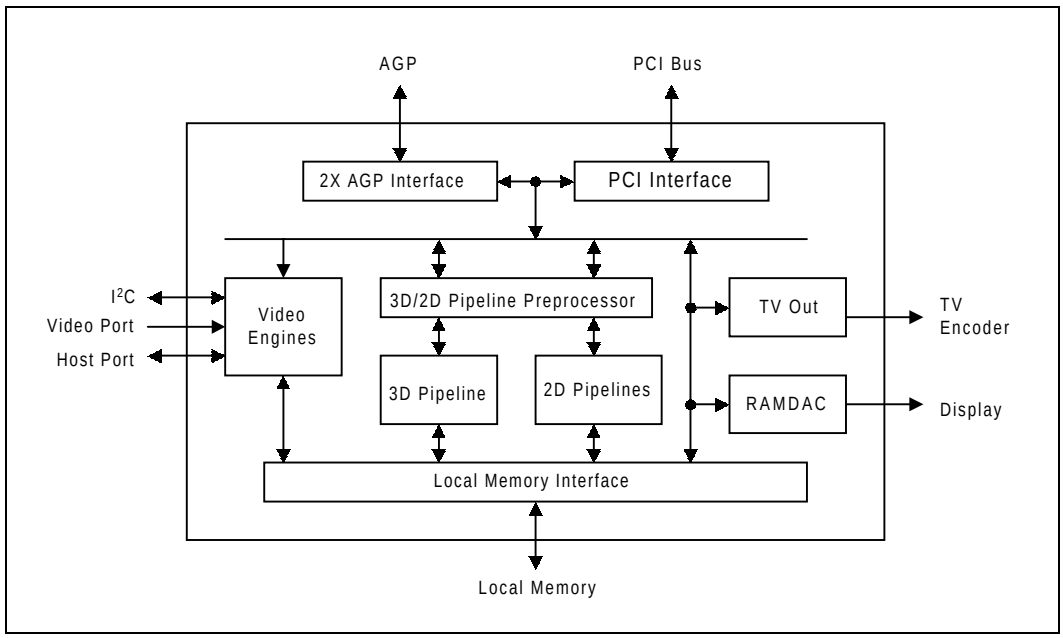
The Intel740™ graphics accelerator is a highly integrated graphics accelerator designed for the Accelerated Graphics Port (AGP). Its architecture consists of dedicated multi-media engines executing in parallel to deliver high performance 3D, 2D and video capabilities. The 3D and 2D engines are managed by the 3D/2D pipeline preprocessor allowing them a sustained flow of graphics data. The Intel740™ graphics accelerator also includes dedicated video engines for support of video conferencing and other video applications.

2.1.1 3D Engine

The Intel740™ graphics accelerator is capable of delivering a high rate of sustained 3D graphics performance with full 3D feature set functionality. This constant high level of performance is delivered through the Intel740™ graphics accelerator's hyper-pipelined 3D architecture and the incorporation of specific graphics architectural enhancements. With the use of Direct Memory Execution (DME), the Intel740™ graphics accelerator fully utilizes the bandwidth of AGP and memory, benefiting the heavy data demands of 3D. DME is a technique that allows the Intel740™ graphics accelerator to store and execute textures in system memory instead of local graphics memory. This provides high levels of performance and unlimited texture sizes.

Architectural enhancements within the 3D pipeline ensure that the Intel740™ graphics accelerator uses this data in the most efficient way possible. Parallel Data Processing (PDP) allows several commands to be executed at the same time in the graphics pipeline. This translates into consistent high-performance regardless of the number of features enabled in a scene. Precise-Pixel Interpolation (PPI) contributes to the hyper-pipelined 3D quality with the Intel740™ graphics accelerator's unique texture engine that delivers precise accuracy in interpolation operations of pixel values and color values. This detailed pixel processing maintains a high level of image quality in every scene.

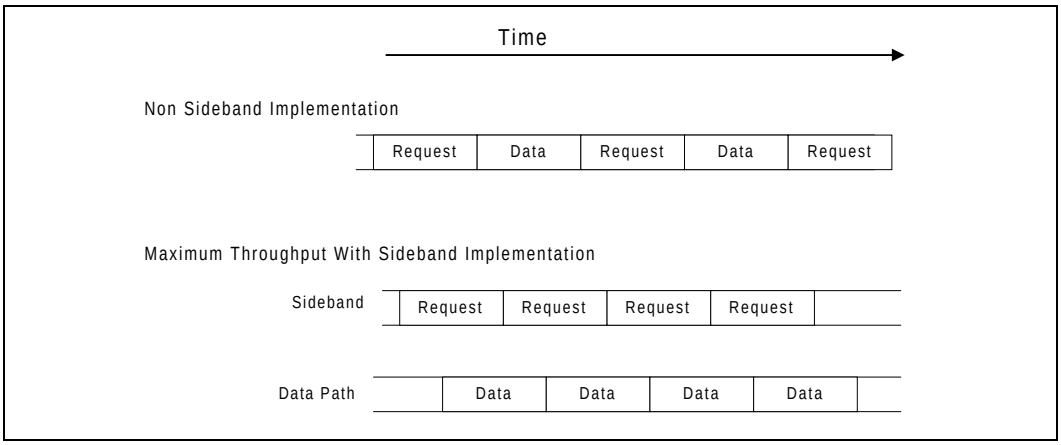
Figure 2-2. The Intel740™ Graphics Accelerator Architectural Interfaces



The DME architecture means that full 2X AGP implementation is integrated into the Intel740™ graphics accelerator with sideband operations supporting Type 1, Type 2, and Type 3 sideband cycles. This allows 533 MB/s peak data transfers. Type 3 support permits textures to be located anywhere in the 32-bit system memory address space. Deep buffering allows the Intel740™ graphics accelerator to receive data at this high rate and handle any latencies associated with AGP transactions.

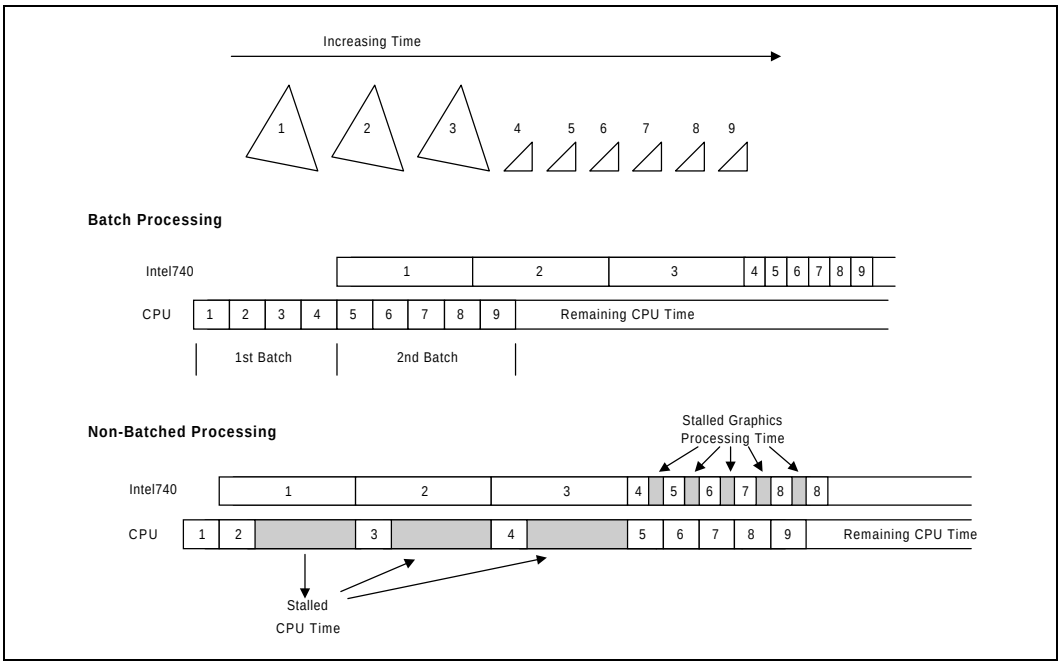
Sideband addressing gives the Intel740™ graphics accelerator the ability to issue multiple requests without having to wait for data to be returned. This allows the Intel740™ graphics accelerator to achieve the highest possible sustained data transfer rates across 2X AGP and makes DME possible.

Figure 2-3. The Intel740™Graphics Accelerator Implementation of Sideband Addressing



To provide the highest level of system concurrency and performance the Intel740™ graphics accelerator is optimized for a batch processing mode of triangle delivery. Batch processing frees up the CPU for intelligent 3D gaming and more complex geometry processing. This batch processing allows the CPU to place a “batch” of triangles in memory and begin on another batch of triangles without the need to perform handshaking with the Intel740™ graphics accelerator.

Figure 2-4. Batch Processing on the Intel740™ Graphics Accelerator—A Conceptual View



The DME capabilities of the Intel740™ graphics accelerator maximize the amount of memory available for rendering (Figure 2-5). The Intel740™ graphics accelerator is capable of executing directly from AGP memory. This “direct execution” avoids the “thrashing” of local memory associated with an architecture that must load local memory from AGP or system memory. As such, textures can be executed directly from AGP memory allowing performance to be sustained even when the texture footprint increases.

As Figure 2-6 indicates, the Intel740™ graphics accelerator is capable of rendering from local memory while textures are being executed from AGP memory through parallel arbitration. This arbitration allows a combined memory peak bandwidth of 1.3 GB/s. The capability to support two open pages in local memory coupled with an additional memory channel in AGP memory supports the 3D rendering model of color (front/back buffers), z, and textures. The Intel740™ graphics accelerator also supports 2D rendering through the use of three raster operands (pattern, source and destination).

Figure 2-5. The Intel740™ Graphics Accelerator's Ability to Execute Textures Directly From AGP Memory

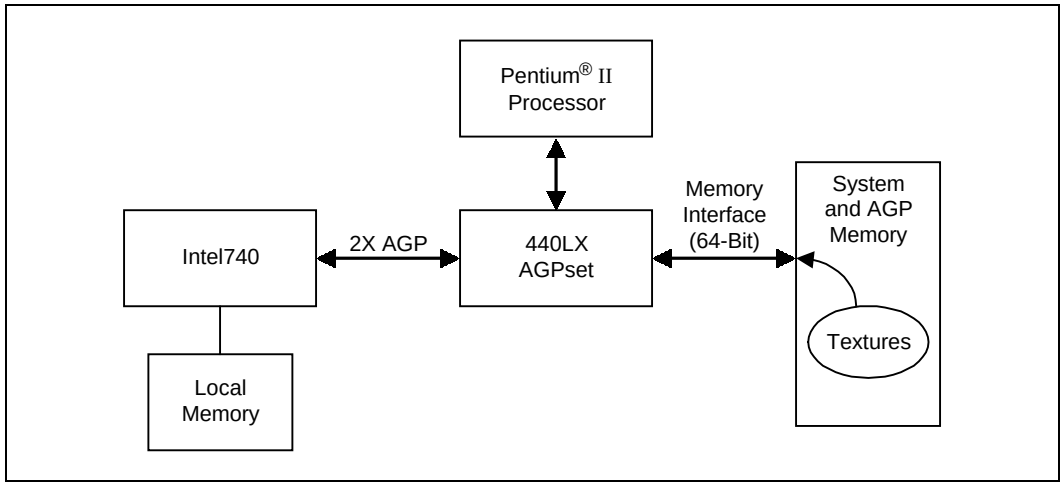
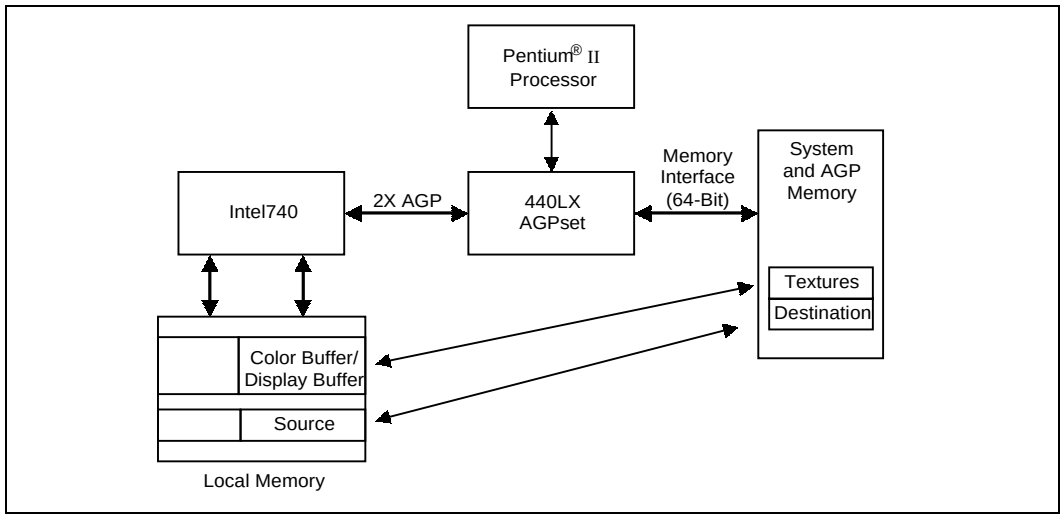


Figure 2-6. The Intel740™ Graphics Accelerator Functioning as Two Memory Controllers



Included in the Intel740™ graphics accelerator's architecture are dedicated 3D pipeline enhancements. These enhancements are designed to manage the way in which 3D data is requested from memory and then used within the compute engine. While parallelism is employed among each of the Intel740™ graphics accelerator's engines, the 3D pipeline calculates 3D data in a highly parallel fashion. With this architecture, the 3D rasterizer is able to compute four fully textured, shaded, fogged and Z Buffered pixels per clock. The 3D pipeline requests data from memory so that memory locality is maximized, regardless of triangle size or orientation. This results in fewer page misses, higher cache efficiency, and a highly sustained 3D graphics output independent of the complexity of the 3D scene being rendered. By combining memory efficiencies and processing data efficiencies, the Intel740™ graphics accelerator is capable of a high rate of sustained 3D performance.

2.1.2 2D Engine

The Intel740™ graphics accelerator's 64-bit BitBLT engine provides hardware acceleration for many common Windows operations. There are two primary BitBLT functions: Fixed BitBLT (BLT) and Stretch BitBLT (STRBLT). The term BitBLT refers to block transfers of pixel data between memory locations. Use of the BLT engine accelerates the Graphical User Interface (GUI) of Microsoft* Windows. Hardware is included for all 256 Raster Operations (ROPs) defined by Microsoft*, including transparent BitBLT. The BLT engines can be used for various functions including:

- Moving rectangular blocks of data between memory locations
- Pixel format conversion
- Data Alignment
- Performing logical operations

2.1.3 Video Module Interface (VMI)

The Intel740™ graphics accelerator VMI consists of a Video Port and a Host Port. The Host Port provides an enhanced VMI 1.4 Mode B Port. The enhancements allow burst modes of operation. The Intel740™ graphics accelerator Video Port is used to receive decompressed video data from a DVD chip or video data from a Video Decoder chip. A CCIR601 digital interface is supported as the primary capture standard. Using both the host and video ports, DVD, TV, Intercast, and video capture can be achieved. Use of the Intel740™ graphics accelerator overlay capability allows images from the capture engine to be displayed while being captured.

2.1.4 Digital TV Out

The Intel740™ graphics accelerator TVout port provides a digital output interface to either a television or monitor. The interface has a 12-bit data bus and connects to a television via a standard TV encoder chip (e.g., a Rockwell* BT869). Output to the encoder is in digital 24-bit RGB format. The following non-interlaced resolutions are supported:

- 320x200
- 320x240
- 640x400
- 640x480
- 720x480
- 720x576
- 800x600

2.1.5 Display

The display function contains a RAM-based Digital-to-Analog Converter (RAMDAC) that transforms the digital data from the graphics and video subsystems to analog data for the monitor. The Intel740™ graphics accelerator's integrated 220 MHz RAMDAC provides resolution support up to 1600 x 1200. Circuitry is incorporated to limit the switching noise generated by the DACs. Three 8-bit DACs provide the R, G, & B signals to the monitor. Sync signals are properly delayed to match any delays from the D-to-A conversion. Associated with each DAC is a 256 pallet of colors. The RAMDAC can be operated in either direct or indexed color mode. In Direct color mode, pixel depths of 15, 16, or 24 bit can be realized. Non-interlaced mode is supported. Gamma correction can be applied to the display output. For further details on the display and display resolutions supported see Section 2.3.3, "Video Display Resolutions" on page 2-44.